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TECHNICAL REPORT  
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DEVELOPMENT OF ICE CREAM PLANT,  
CONTINUOUS FLOW, PORTABLE

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and

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March 1968

UNITED STATES ARMY

MANUFACTURING LABORATORY

GENERAL EQUIPMENT & PACKAGING LABORATORY

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TECHNICAL REPORT  
68-36-GP

DEVELOPMENT OF  
ICE CREAM PLANT, CONTINUOUS FLOW, PORTABLE

by

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and  
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Food Service Equipment Division

March 1968

General Equipment & Packaging Laboratory  
U. S. ARMY NATICK LABORATORIES  
Natick, Massachusetts

## **FOREWORD**

The development of a self-contained, continuous flow, ice cream plant was authorized as a Commander's List project by the U. S. Army Materiel Command in the second quarter of Fiscal Year 1966. Mr. Bruce B. Thomas, Food Service Equipment Division, General Equipment and Packaging Laboratory, served as project officer, and Mr. Frederick W. Franke was the alternate project officer.

Acknowledgment is accorded to personnel of the Laboratory Support Office for their assistance in the evaluation of the continuous flow ice cream plant.

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## ABSTRACT

Development of a continuous flow, portable, ice cream plant was undertaken to meet requirements for a unit with a minimum output of 50 gallons of ice cream per hour that could be transportable by a 2-1/2-ton vehicle.

The main components of the plant were to be a continuous flow freezer, refrigeration system, mix tank, pump, and mounting base. These individual components were available commercially, but a complete, portable plant had never been built with its own refrigeration system.

After initial design of the units, two plants were built by commercial sources and tested by the manufacturers. Further evaluation was conducted at the U. S. Army Natick Laboratories. Results of tests indicated satisfactory operation of the experimental prototypes, and that the design concepts and available hardware were acceptable.

## DEVELOPMENT OF ICE CREAM PLANT, CONTINUOUS FLOW, PORTABLE

### Statement of Objective.

The present ice cream machines available for military field use are of the "batch" type which produce approximately three 2-1/2-gallon batches of ice cream per hour. To produce any large quantity of ice cream, it would be necessary to operate several machines at one time. This type of operation is inefficient and requires a large number of machines and personnel.

The objective of a continuous flow ice cream plant (Figures 1 and 2) now under development, is to produce ice cream in excess of 50 gallons per hour. The rated conditions for producing the 50 gallons per hour were established at 100° F. and an overrun\* of 90 percent.

An additional objective is a complete, self-contained plant, capable of being transported by a standard 2-1/2-ton military vehicle. The refrigeration system was to be provided with an air-cooled condenser. Electric power would be supplied at the operational site.

### Development of Continuous Flow Ice Cream Plant.

Initial investigation of continuous ice cream freezers revealed that the freezer units were available as commercial items from two manufacturers. Each of these manufacturers has produced these freezers in excess of 20 years. These freezer units are highly developed and have proved reliable in use throughout the commercial ice cream industry. Other components required for the plant were commercially available, although they had never been assembled as a unitized system.

Discussions held with each of the two manufacturers revealed that the self-contained, continuous flow, ice cream plant was feasible and that a compact unit could be fabricated. Contracts were awarded to each company to produce one prototype unit of the ice cream plant. These units were manufactured and tested at the vendors' plants prior to shipment to these Laboratories for further evaluation.

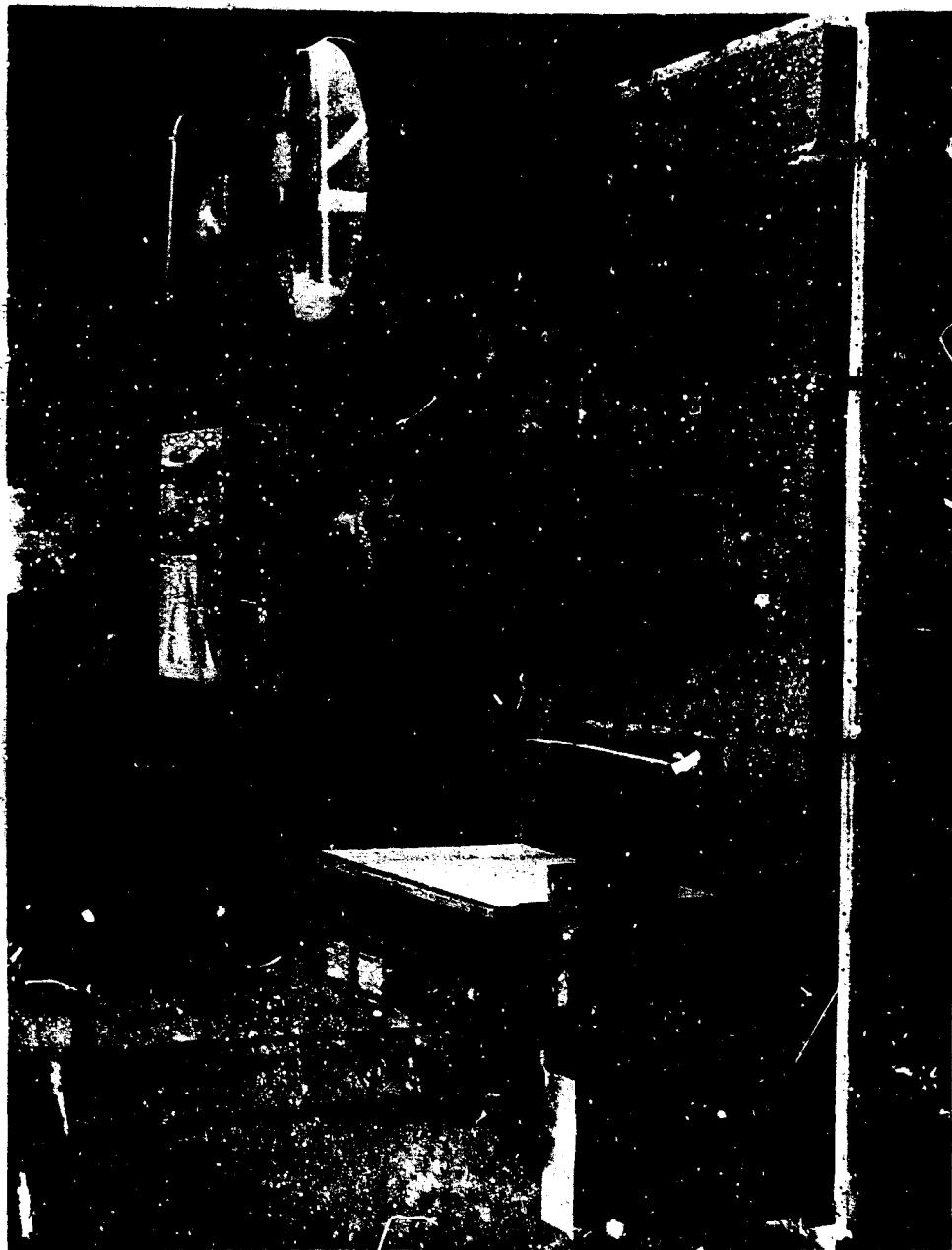
\*Overrun, as applies to ice cream making, is the ratio of air to liquid mix, by volume of the finished product. It is the volume of the finished product over and above the volume of liquid mix used to make the product.

Example: One gallon of liquid ice cream mix will produce two gallons by volume of finished product = 100 percent overrun.



Figure 1. EXPERIMENTAL PROTOTYPE OF CONTINUOUS FLOW ICE CREAM PLANT.

Figure 2. COMMERCIAL TYPE - CONTINUOUS FLOW ICE CREAM PLANT.



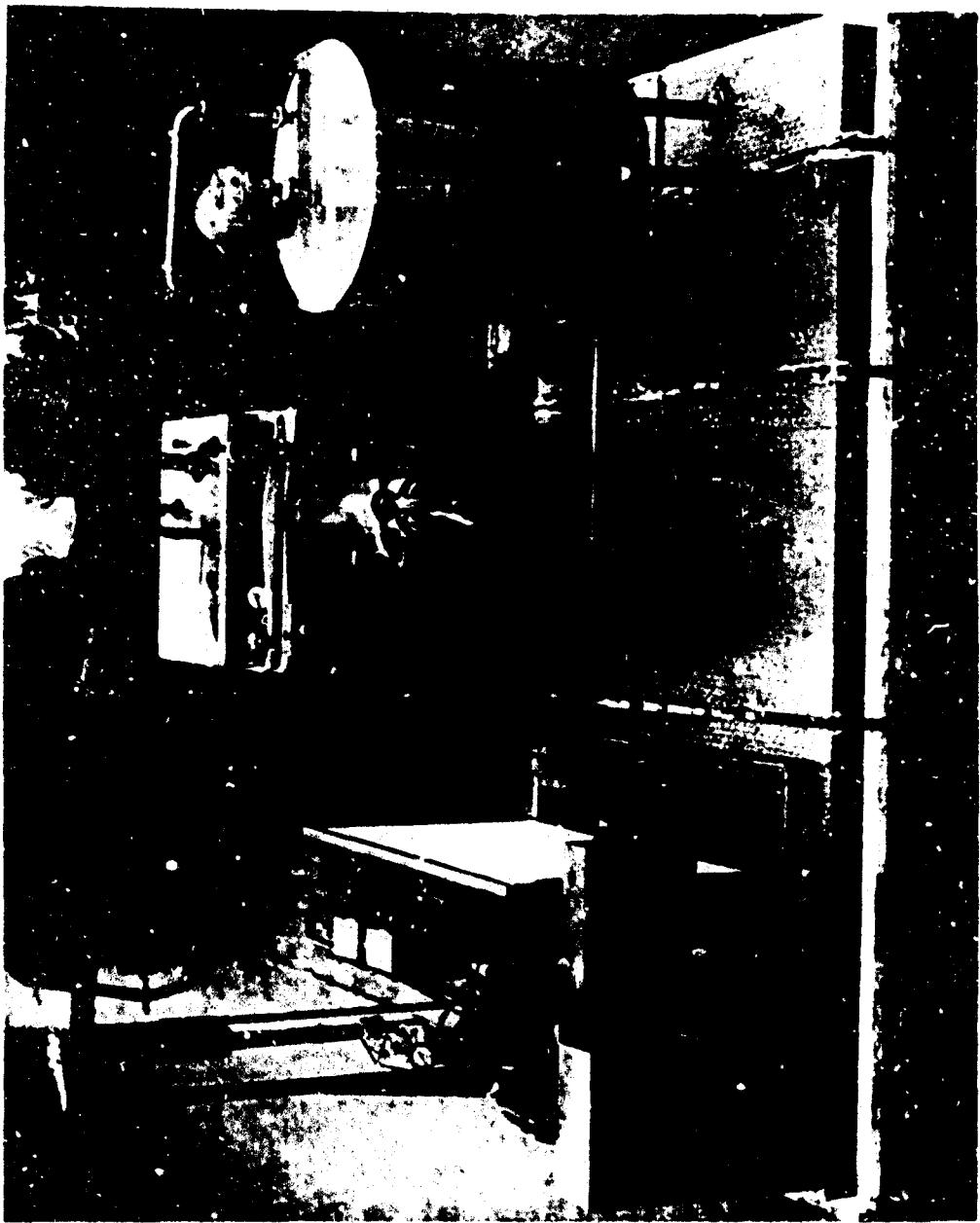


FIG. 4. - COMMERCIAL TYPE - CONTINUOUS FLOW ICE CREAM PLANT.

Both units were evaluated at these Laboratories for ease of operation, location of components, ease of maintenance, structural integrity, and ease of cleaning.

The two prototypes were procured with different components and methods of fabrication. One unit had a solid plate over the framework for the operator to walk on, and the other unit was left open for cleaning, since the operator did not have to walk on the unit to operate it. One unit had a refrigerated mix tank for storage (Figure 3) and the other a funnel-type mixer (Figure 4) for easily dissolving the powdered ice cream mix. In addition, one unit was built with welded piping, while the other unit had piping that could be completely dismantled for cleaning.

#### Results.

Both of the units performed well with the exception that when using some ice cream mix the plants would not produce a full 50 gallons-per-hour output with a mix temperature of 90° F. and an ambient temperature of 100° F. Design performance figures for both freezers were prorated from data on ammonia performance. Operation with R502 (refrigerant) showed that the capacity of the plants was not sufficient to cover all variations in ice cream mixes. With a mix temperature of 70° F., however, the requirement of 50 gallons-per-hour output could be met using military ice cream mix per Military Specification MIL-I-705C.

Operation of one unit was hampered when the hot air from the air-cooled condenser blew over the freezer and the operator while the unit was running (air flow direction was corrected at U. S. Army Natick Laboratories).

When operating each unit with dry powder ice cream mix, it was difficult to dissolve the powder in the mix tank. Although an agitator is supplied in the tank to keep the mix from stratifying prior to use, this is not sufficient for initial dissolving of powdered mix. The dissolving of the mix was accomplished satisfactorily in an outside pan or by using a funnel-mixing device.

Cleaning both units was found to be satisfactory. The comparison of welded piping versus coupled piping can only be resolved satisfactorily after extended field operation. This matter is more of a convenience factor than that of meeting sanitary requirements.

Recirculating pumps between the mix tank and the freezer were very useful for cleaning the units as well as providing very consistent operation of the freezers.



Figure 3. ICE CREAM PLANT WITH REFRIGERATED MIX TANK FOR STORAGE.

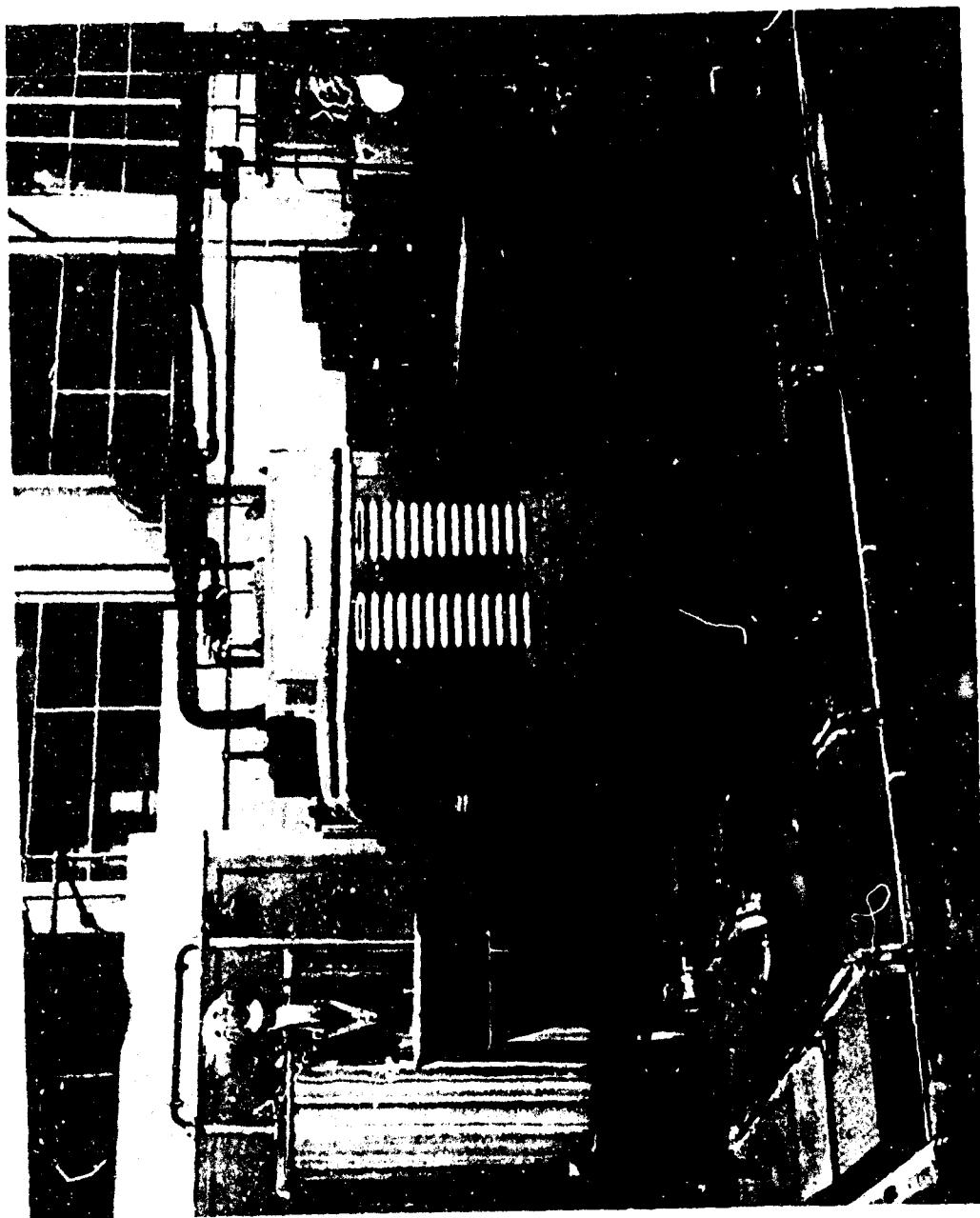


Figure 4. UNIT WITH FUNNEL TYPE MIXER.

### Conclusions.

The continuous flow ice cream plant is acceptable for production of large quantities of ice cream.

The plant is suitable for transport by a 2-1/2-ton truck and needs only shelter, electrical power, and potable water supply to set it up for operation. Freezer cabinets are required as a separate item for hardening the ice cream after it leaves the freezer.

Capacity of units is very good at 100° F. ambient, with a mix temperature below 70° F. The freezers were not designed to be efficient with mix temperatures above 70° F. There is no problem in operating with high mix temperatures, but the capacity of the units will be slightly below the initial requirement of 50 gallons-per-hour output.

In areas where refrigeration is available to cool the mix prior to use, the capacity of the units would increase to 100 gallons-per-hour output.

The ice cream plants are suitable for continuous (24 hours per day) operation, and production is limited only by cleaning requirements and minor periodic maintenance.

### Recommendations.

The continuous flow ice cream plant should be specified with funnel mixing devices for dissolving the powdered ice cream mix.

The capacity requirements should be stated as 50 gallons-per-hour output at 90 percent overrun, with a mix temperature of 70° F., while operating in an ambient temperature of 100° F.

Air flow from the air-cooled condenser should be directed away from the unit so that cool air is drawn over the freezer and operator.

The type of piping should not be specified until field use has determined whether welded or coupled piping is more suitable.

Skids for ice cream plants can be either open-frame or steel-plate covered, depending on whether the operator must stand on the skid or on the floor beside the unit.

Refrigerated mix tanks are not required for the continuous flow ice cream plants since they will be used for volume production, and there will be no requirement for mix storage in the tanks.

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